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A Predictive Artificial Potential Field Method for Virtual Coupling Train Control

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In response to the growing demand for rail transport, next-generation signalling systems are increasingly investigated by the railway community. In particular, the concept of Virtual Coupling (VC) is progressively gaining ground thanks to its potential ability to reduce safe train separation to less than an absolute braking distance allowing trains to move synchronously in a vehicle-to-vehicle radio-connected convoy. One of the major concerns associated with this concept is the safe and effective control of trains in a convoy when considering varying train resistances and risk factors due to, e.g., sudden degradation in the train and communication performance. This paper develops a novel Predictive Artificial Potential Field (PAPF) approach for safe and effective real-time train control under realistic VC operations. The proposed approach uses a realistic homogeneous strip model of train motion and refers to a dynamically changing safety margin to take into account risk factor occurrences such as delays in train control and communication, or sudden emergency braking applications. A simulation-based assessment of the developed method is performed for a high-speed rail corridor in China. Results show that the proposed PAPF control algorithm effectively supervises the safe train separation preventing activation of emergency brakes even when risk events occur. The method contributes to advancing the state of the art on VC train control.